

We may reduce these to a common epoch by applying to the former dip the correction  $-0^{\circ}96$ , this being the proportional secular change (as shown by these six years) necessary to reduce the former epoch to the latter. The former dip will therefore become  $68^{\circ}6'83 - 0^{\circ}96 = 68^{\circ}5'87$ .

Reducing in the same way the horizontal force, we have

$$3.8346 + 0.00275 = 3.83735.$$

The values thus become as follows :

	Hor. force.	Dip.
From the April to September observations } (reduced to epoch July 1, 1866) . . . . . }	3.83735	$68^{\circ}5'87$
And from the October to March observa- } tions (corresponding to the same epoch) }	3.83720	$68^{\circ}6'41$

The total force derived from the first series will therefore be  $10.28717$ , and that derived from the second series  $10.29080$ , showing thus a difference of  $0.00363$  in British units as the measure of the greater intensity of the terrestrial magnetic force in the October to March period, than in the April to September period. This is in the same direction, and very nearly of the same amount, as that determined by Sir E. Sabine from the first six years, which exhibited a similar difference of  $0.00317$  in British units.

Thus we find that the two series agree in showing nearly the same semi-annual variation for the total force, while the first period exhibits the greatest semiannual variation of the dip. It ought, however, to be borne in mind that the two series bear a different relation to the disturbance period, the maximum of disturbances occurring about the middle of the first series, and the minimum near the middle of the second.

## II. "Spectroscopic Observations of the Nebula of Orion, and of Jupiter, made with the Great Melbourne Telescope." By A. LE SUEUR. Communicated by the Rev. T. R. ROBINSON, D.D. Received January 27, 1870.

In one particular the spectroscopic observations of the nebula of Orion are not void of interest ; they show distinctly that considerable nebulosity exists *within* and about the trapezium. The image at the slit is sufficiently large to well separate the stars of the trapezium, so that when two of these are, as it were, threaded on the slit, a clear space lies between them ; this in the spectroscope gives the well-known lines with little, if at all, less brilliancy than the general bright nebula.

The small comparison-mirror being removed, the available slit is  $\cdot 4$  inch high, equivalent in the case of the Cassegrain image to about  $43''$  arc ; with an image condensed about three times (which is the usual arrangement and still allows sufficient separation), the slit may, therefore, be made to considerably overlap the trapezium contour, and thereby, at the same time as the trapezium, light from the brightest part of the nebula is under inspection ; it is curious to see that the spectral lines run with almost continuous brightness throughout the height of the slit.

Inaccuracy of focus of the image on the slit might perhaps somewhat mislead, but this has not been allowed to come into play; for the focus is readily adjusted with considerable delicacy, by examination of the breadth of star spectrum, which is reduced to a minimum.

In Sir John Herschel's Cape drawing, a slight nebulosity is seen within and immediately about the trapezium; and in the description is found the following extract from note-book :—"In the interior of the trapezium there exists positively no nebulosity, at least none comparable in intensity to that immediately without it."

There being (as far as I can now see or remember) no other special reference to this matter in the description, it is not quite clear whether or not the nebulosity in the drawing rests on this evidence or on that of other nights when it may have been more conspicuous.

In Lord Rosse's drawing the trapezium is enclosed in, and itself encloses, a space totally free from nebulosity. My own telescopic observations here (on not good nights unfortunately) indicate a positive though comparatively faint nebulosity within and about the trapezium, somewhat as in the Cape drawing; the spectroscope, however, shows with much force that this nebulosity not only exists, but is comparable in brightness to that surrounding the trapezium at some distance,—the brightest part of the nebula in fact; and therefore that, in ordinary observation, the faintness or apparent complete absence of nebula is mainly due to the disturbing brightness of the four stars, and not to any intrinsic extreme faintness or absolute vacuity.

Jupiter has been examined with results, if not, as far as may be judged at present, important, at least interesting. Here, again, the large size of image is brought into prominent play; with the original Cassegrain image the light is barely sufficient, but with the image condensed (at pleasure within certain limits) fair work becomes possible, the spectrum being considerably bright.

The lines G, F, C, D, are seen without the slightest difficulty, C (being near to visible limit) not so readily, but unmistakably, and many other lines with attention. A marked feature is a dark nebulous band between C, D; from measures this turns out to be one of the bands examined by Mr. Huggins, 882 of his scale\* ( $C_6$  of Brewster?).

The observations were made generally with Jupiter not far from the meridian. On one night only of those employed was the atmosphere at all free from perceptible haze; as far, however, as memory could be trusted, there did not appear to be any perceptible difference in the intensity of the line on the different nights. This line is always so conspicuous that, were it not for Mr. Huggins's more critical observation, I would be inclined to think that in Jupiter it is much stronger than in an equally bright daylight spectrum, under conditions even more favourable than those afforded by the

\* [Wrong identification: see next paper.]

altitude of the planet and the state of the atmosphere at the times of observation ; considering, moreover, that in Mr. Huggins's observation (as he himself remarks) the relative positions of the sun and Jupiter were such as considerably to exaggerate the effect of the earth's atmosphere on the sky spectrum, it is difficult (in the absence of a more crucial observation pointing in a contrary direction) to escape the impression that this line is in no small degree due to Jupiter's own atmosphere. The band specially examined by Mr. Huggins I have not yet succeeded in seeing with any degree of certainty ; but the opportunities have been so few, that the optical conditions for its most favourable development have not been fairly tried.

On one night the eye-aspect of Jupiter was as follows :—N to P (Plate I. fig. 1) of yellowish colour, with occasional appearance in good defining moments of hair-line structure ; P to Q almost white, slight tinge of blue ; Q to R yellowish, but much darker than N P ; R to S also yellow, slightly brighter than N P, and with no suspicion of fine lines.

P, Q, R brown, much darker than general surface, the two latter with a red or yellow tinge, the former with a greenish one. [These are merely the impressions without attempt to eliminate effect of contrast.]

The absolute positions and definite shape of these bands, as given in the diagram, have no special pretensions to minute accuracy ; considerable care was, however, employed, and in any case the sketch in its broad features is sufficiently near to the truth for the special purpose in view. In the spectrum, G, F, E, D, C<sub>6</sub>, C are laid down from measures on Jupiter. I have called the band between C, D, C<sub>6</sub> for reference purposes, subject to rectification, although there can, I think, be little doubt of the coincidence.

A point specially aimed at in these observations was to note any peculiarity in the appearance of spectral lines of known atmospheric origin according to the part of the surface viewed.

With the slit perpendicular to Jupiter's equator and the advantage of a large image, an admirable opportunity is afforded of noting the behaviour of the lines as they cross the different parts of the surface, a spectroscopic picture of the planet, as it were, being presented beautifully to the eye.

The nebulous line C<sub>6</sub> was specially and narrowly watched, but without any satisfactory evidence being elicited ; as this line crosses the bright band P Q it is perhaps slightly less nebulous ; on the assumption that C<sub>6</sub> is in great part due to Jupiter's atmosphere, this peculiarity, by no means marked, is yet in the direction to be accounted for by the usual suppositions concerning the nature of Jupiter's visible disk. On this assumption, however, one would expect more decisive evidence of change in the line according as it is due to the cloud-band or to the surface ; there is evidence certainly, but so faint that, due regard being had to the possible disturbing effect of the somewhat greater brightness of cloud band, and to the bias which cannot be totally eliminated from the mind, it does not seem entitled to much weight.

This almost, if not altogether, complete sameness of the line might perhaps

(on the foregoing assumption) be accounted for by supposing that the cloud-bands are very near the surface, so near that the light reflected therefrom has to pass through a thickness and density of atmosphere comparable in its effects to that above the more uninterrupted parts of the surface.

Further observations may obviate the necessity for this or any other more feasible explanation, by proving that the band is mainly due to the earth; but, as before shown, the weight of evidence, Mr. Huggins's observation taken into account, is in favour of the assumption that the line, as seen on Jupiter at considerable altitude, is mainly due to the planet itself.

The general appearance of the spectroscopic image is one of nearly uniform brightness, with the marked exception of the brighter band P Q, and the much darker band Q R: in this band the principal absorption takes place at the more refrangible end of the spectrum, where it is very considerable, gradually diminishing, but yet conspicuous, up to E; at moments it may be traced very faintly up to D, with no certainty beyond.

In this band Q, R are not separable; considering the size of the image this can hardly be due entirely to closeness, but would seem to show that (at the more refrangible end at least) the absorption of the yellow and somewhat dark space enclosed between Q, R is little inferior to that of Q, R themselves. P is not conspicuous, but is unmistakably seen in good moments as a narrow streak at the blue end.

The experiment was made of placing the slit parallel to the planet's equator; when in this position and moved slowly over the surface, or arrested at particular points, no peculiarity was distinguishable; so little do the parts differ in brightness, that by this method it could not, from the mere evidence of the spectrum, be told what part was being admitted through the slit; in this method, however, greater delicacy of adjustment is required, for slight want of parallelism of the slit to the bands brings in disturbing effects.

The edges of the disk were examined, but without result.

Observatory, Melbourne, December 5, 1869.

### III. "On the Nebulæ of Argo and Orion, and on the Spectrum of Jupiter." By A. LE SUEUR. Communicated by Prof. G. G. STOKES, Sec. R.S. Received February 21, 1870.

Among the following observations made with the great Melbourne telescope, the most important are those of  $\eta$  Argo; the spectrum of this star is crossed by *bright lines*.

The mere fact of a bright-line spectrum is not very difficult to ascertain on a good night; for although from faintness of the light the phenomenon is necessarily delicate, yet the bright lines occasionally flash out so sharply that the character of the spectrum cannot be mistaken. The most marked